48.4: Development of High-Contrast CRT based on Nano Pigment Screen Technique

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Abstract

We have developed the NPSCN (Nano Pigment Screen) technique, a new style phosphor screen and successfully applied it to the CRT TVs. The technique significantly improved contrast, color gamut and body color in comparison to the previous CRTs without any additional process or investment cost.

1. Introduction

Before 1990th, most of the members of all display companies and researchers in any places related to display techniques generally have worked for the CRT technology. But the circumstances were rapidly changed. Nowadays major concerns are focused on new FPDs in market such as PDP, LCD, FED (or SED) and OLED etc. Therefore, CRT business is changing from leading to surviving with FPDs. Ways to compete with FPDs could be cost competability, picture quality, new design and so on. All of the above methods are required to minimize cost and investment in these days. Recently Samsung SDI combined with Samsung Electronics is launching slim type CRT TV named by "Vixlim". A lot of efforts have been strongly requested with development of slim CRT that its thickness approaches FPDs while maintaining highest picture quality. NPSCN technique was developed to improve picture quality.

Contrast and brightness are extremely important parameters determining picture quality in display. Contrast is the ratio of external radiant phosphor emission to the reflected ambient light [1]. A further improvement of contrast for CRT is possible by reducing transmission of panel glass and thickening outer coating in external and mixing low reflective materials such like pigments with phosphor in internal. It is difficult to change the transmittance of panel glass because of various customer requirements and production of glass makers in large scale. In case of outer coating, coating raw material includes several noble metals that can grow cost as thickness of coating film is increased. Above all those methods generally can control only transmittance. So the decrease of brightness is more severe than the case of properly using pigments that have the characteristics of selectively optical absorption by different colors.

Pigments have been used for higher contrast and color gamut for a long time. We can divide the application methods of pigments for CRT picture quality as follows. One way is coating pigments on the surface of phosphors. And then use the pigmented phosphor in screen process like bare phosphor [2]. This is very simple and stable method. But the pigmentation process that attaches pigment to the surface of phosphor particles needs some binding material such as SiO_2 or gelatin that is activated usually in the acidic atmosphere. If well dispersed nano pigments are inserted into the pigmentation process, they are heavily aggregated and then lose their high selective optical absorption property. Finally the phosphors coated with the aggregated pigments show the lower pigment efficiency that could be defined as contrast increment to the brightness reduction. Therefore very small amount of pigment can be useful for contrast and color gamut [2, 3]. Second is the case using nano size pigments like "Color Filter (CF)". It is produced as a separated film in front of phosphor screen. So it can be used without pigment aggregation because it is not required for the pigmentation process that induces aggregation of nano size pigments. Improving contrast and color gamut is very high while brightness decreasing is low[4, 5]. But the critical problem is that this requires a lot of investment cost about $10 million/line and raising production cost. In conclusion, both techniques have trade-off relation between effects and investment.

NPSCN was developed to utilize nano pigment without additional investment and effect deterioration. The idea of NPSCN was started as follows. If well dispersed nano pigments are mixed with phosphors in slurry that includes several surfactants and PVA in neutral pH, we can prevent pigment aggregation. So one can get higher pigment efficiency. The adhesive force between pigment and phosphor in phosphor slurry is based on electrical charge differences. The improvement of pigment efficiency is due to both the selective light absorption effect of nano pigment and the distributed phosphor screen made by fast sedimentation of NPSCN. Figure 1 shows the difference of the above three pigment application methods. In conclusion, NPSCN improved contrast about 20% without any additional process or cost. Additionally, this technique applied to CRT TVs improved color gamut & body color. The most attractive merit is that it can be directly applied to the established manufacturing process with little changes. And this technique makes it possible to change picture quality with ease by controlling pigment input amounts. In this paper we will introduce the mechanism, key factors and effects of NPSCN.